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ABSTRACT

Elementary teachers have a significant responsibility to foster children's abilities to read and write; today they are also encouraged to incorporate technology in their classrooms. This article reports results from an ethnographic study that examined the inquiry and process writing approaches a fourth-grade teacher used in a classroom where literacy instruction and a rich technological environment were successfully integrated. The article discusses both the approaches and the challenges the teacher encountered, which included addressing students' abilities to analyze sources, create quality products, and deal with conflicting information. The article reports that the classroom fostered important literacy skills, such as valuing substantive over flashy results and learning to verify and reference information. The article also explores how the study's findings may provide helpful insights to elementary teachers who seek to integrate literacy instruction and technology. (Contains 41 references.) (EF)

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Instructional Approaches Used to Integrate Literacy and Technology.

by Elizabeth A. Baker

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Instructional Approaches Used to Integrate Literacy and Technology

Elizabeth A. (Betsy) Baker

Abstract

Elementary teachers have a significant responsibility to foster children's abilities to read and write; today they are also encouraged to incorporate technology in their classrooms. This article reports results from an ethnographic study that examined the inquiry and process writing approaches a fourth-grade teacher used in a classroom where literacy instruction and technology were successfully integrated. The article discusses both the approaches and the challenges the teacher encountered, and explores how the study's findings may provide helpful insights to elementary teachers who seek to integrate literacy instruction and technology.

Related Postings from the Archives

- Maureen Carroll, Dancing on the Keyboard
- David Lund & Deborah Sanderson, From Printed Page to Multimedia

Approaches | Integration | Method | Findings | Challenges | Discussion | References | Acknowledgments

By the time children finish elementary school (at approximately age 11 in the United States), they are expected to be able to read proficiently and discuss fiction and nonfiction texts, as well as compose with conventional spellings, grammatical structures, and punctuation. At the same time, with such things as Internet-connected computers increasingly available in elementary schools, teachers are being encouraged to incorporate technology in their curricula. This article examines the instructional approaches that one fourth-grade teacher used successfully to integrate literacy instruction and technology in her classroom.

The Instructional Approaches

Ethnographic methods revealed that the teacher used both the inquiry approach and process writing in her literacy program. The *inquiry approach* gives students the opportunity to identify topics in which they are interested, research those topics, and present their findings (Leu & Kinzer, 1999; Macrorie, 1988). This approach is designed to be learner centered as it encourages students to select their own research topics, rather than being told what to study. Some teachers find it necessary to modify the inquiry approach because their schools or districts require them to teach certain topics. For example, in a district that requires second graders to learn about neighborhoods, a teacher using a modified inquiry approach might encourage children to identify particular topics they want to research within the broad area of neighborhoods.

Opportunities for collaboration are frequently present within the inquiry approach because learners who choose similar topics often decide to research and present together. Further, inquiry units provide opportunities for integration across content areas. While the learners conduct their research and prepare their presentations, they can incorporate aspects of social studies, science, math, and literature study. In terms of literacy, the teacher can provide reading and writing instruction to children as needs are exhibited.

With the *process approach to writing instruction,* children of all ability levels brainstorm, draft, edit, revise,

and publish their own writing (Graves, 1983; Harste, Short, & Burke, 1988). Unlike in basal programs, in process writing children do not progress through a predetermined sequence of writing skills. Instead, the teacher carefully observes writing activities and provides minilessons for individuals, small groups, and the whole class when children demonstrate the need for a skill at different stages in the writing process. This approach fosters collaboration by providing young authors with opportunities to share their writing, at which time they receive feedback and together explore the reading-writing connection (Baker, Rozendal, & Whitenack, in press; Tierney & Shanahan, 1996).

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Integration of Literacy Instruction and Technology

A growing body of research examines aspects of integrating literacy instruction and technology (see, e.g., Leu, 2000; Reinking & Bridwell-Bowles, 1996; Reinking, McKenna, Labbo, & Kieffer, 1998). One area of this research examines the impact of word processors on written expression (e.g., Cochran-Smith, 1991; Edinger, 1994; Labbo, 1996). While some research has found either no significant results or mixed results with regard to the effect of word processors on literacy development (Hunter, 1990; Joram, Woodruff, Bryson, & Lindsay, 1992), most studies have shown word processors to be beneficial. This technology mitigates the difficulties young children often experience with the fine-motor control necessary for letter formation (Chang & Osguthorpe, 1990) and facilitates revision (Baker & Kinzer, 1998).

Further, MacArthur (1996) found that difficulties encountered by learning-disabled students in expressing themselves in writing were lessened by the use of word processors, transcription software, spell checkers, speech synthesizers, multimedia applications, and semantic organizers (see also Tierney, Kieffer, Whalin, Desai, Moss, Harris, & Hopper, 1997; online document). Other studies indicate that word processors can increase collaboration and active involvement among students (Baker, Rozendal, & Whitenack, in press; Bruce, Michaels, & Watson-Gegeo, 1985), strengthen students' focus on the content they are writing about (Cochran-Smith, Paris, & Kahn, 1991), and, compared with paper-and-pencil compositions, increase lexical density, revisions, cohesion, and metacognitive talk (Jones & Pellegrini, 1996; Klenow, 1992; Moeller, 1993).

Research that focuses on the impact of the World Wide Web and electronic communication on development of writing abilities indicates that through Internet technologies, students can find support for their writing efforts (Anderson-Inman, 1997), increase their awareness of audience (Gallini & Helman, 1995), and gain useful feedback (Guhlin, 1996).

Although these studies offer valuable insights into the effectiveness of various technologies for fostering children's reading and writing abilities, they do not offer systematic examinations of the instructional approaches used in literacy programs that integrate those technologies. Zorfass (1992) examined the inquiry approach and its effectiveness in integrating technology into middle school classrooms. Zorfass and Copel (1995) found that middle school students who followed the inquiry approach across content areas learned to ask intriguing questions and gather information from a wide range of resources. They also reported that the teachers were able to assess student progress throughout the unit instead of being limited to an end-of-unit test. However, the collaboration required of the various content area teachers, though worthwhile, was time consuming.

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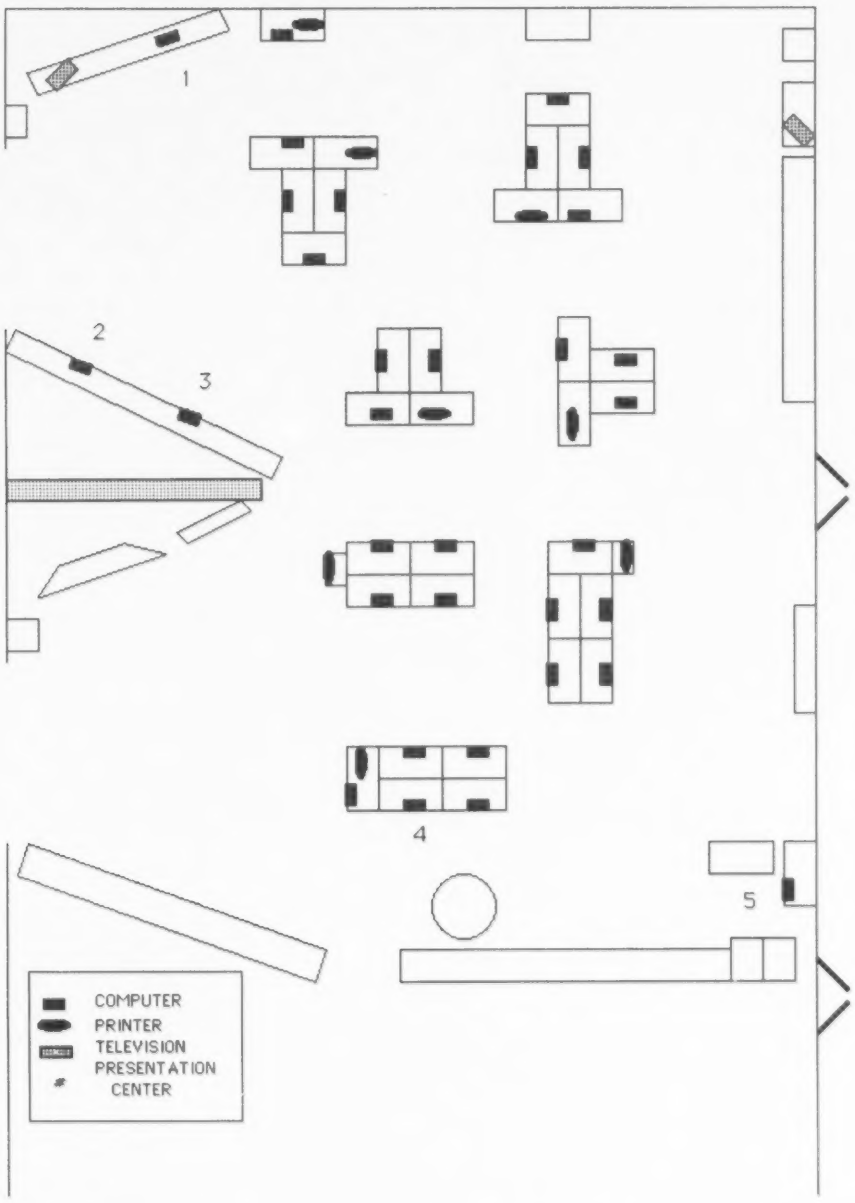
Method

Setting and participants. The study was conducted in a fourth-grade classroom in a suburban public elementary school located in the southeastern United States. Eight years earlier, one third- and one fourth-grade classroom had been equipped with multiple technologies. The technology-rich classroom in this study had 35 computers, 10 printers, 2 CD-ROM drives, 2 televisions, and a cartridge drive (used primarily for capturing video), video recorder, video camera, laser disc player, modem, telephone, and scanner. The school employed a part-time technician who installed software and received district support to repair all types of equipment.

Each student in the fourth-grade classroom had a personal computer on his or her desk as well as access to five multimedia work stations (see Figure 1 below for a floor plan of the classroom). The remaining four computers were available in the event that enrollment increased but, because this did not occur during the school year in which the study occurred, the students used them for multitasking. For example, if they needed to print something or edit a layout, they used the extra computers while their own desktop computers continued to be available for word processing or to run other applications. In addition, the students could access materials found on CD-ROMs, laser discs, the World Wide Web, videotapes, and filmstrips (often with narration on accompanying cassette tapes), as well as read and refer to textbooks, trade books, and magazines.

Figure 1
Floor Plan of the Fourth-Grade Classroom



The parents and guardians of second graders completed applications if they wanted their children to spend third and fourth grade in the technology-rich classrooms. School faculty members reviewed these applications

to create 4 third-grade classes. They purposely made each class comparable in terms of distribution of children by race, gender, socioeconomic status (based on children's participation in a subsidized or free lunch program), and academic ability. The children placed in the third-grade technology classroom progressed to the fourth-grade technology classroom.

In the year of the study, the fourth-grade class consisted of 26 students: 13 boys and 13 girls. There were 3 African-American girls, 1 African-American boy, and 1 Hispanic girl; the remaining children were European American. Forty-four percent of the children received free lunch. Twenty had been in the third-grade technology classroom, while the remaining six were placed in this class because of the need to balance enrollment across fourth grade classes as students moved into or out of the neighborhood from which the school drew its population. The teacher described the class as "average" in ability, noting that no student qualified for special, remedial, or gifted services.

The classroom teacher, Ms. Jones (pseudonyms are used for the teacher and students), had more than 20 years of teaching experience in public and private schools across the southern United States. Two years earlier, she had been named Teacher of the Year in her district. The year this study was conducted was her first year teaching fourth grade; in the ten years prior to the study, she had taught grades 1 and 2. During a formal interview, when I asked Ms. Jones about her teaching philosophy, she replied,

> I have always done thematic teaching...nobody ever told me to do that. I just always liked to collect books on oceans, liked to collect books on insects, liked to collect, you know, whether it was a real [scientific] textbook or make-believe spiders save the day or whatever.... I really got into the whole language thing...some years ago. I know in '86 I went to [a whole language] conference.

While she had used thematic units throughout her career, Ms. Jones pointed out in later discussions that this was her first year using inquiry units. This was also her first year in a technology-rich classroom. (There had been one computer in her previous classroom, where she had taught for five years.) Ms. Jones frequently discussed technological and instructional challenges and opportunities with the teacher in the third-grade technology-rich classroom.

Data collection and analysis. To capture the events of the classroom, I attended as a participant-observer for several hours each day from January to June. While in the class, I took extensive observation notes; later each day I expanded these into complete thoughts while watching corresponding videotapes and reviewing collected artifacts. The expanded notes were coded into four categories (Corsaro, 1985):

1. Field notes -- descriptions of observed activities and social interactions
2. Theoretical notes -- my interpretations of these activities and interactions
3. Methodological notes -- notes about intrusiveness, shifts in methods of data collection, and emerging themes pertinent to data analysis
4. Personal notes -- personal reactions to the classroom situation

The inquiry and process writing approaches were evident immediately. While I was describing my research interests to Ms. Jones before starting data collection, she stated that she used these approaches. Data collection and analysis therefore focused on confirming Ms. Jones' statements and understanding how these approaches were used to integrate literacy instruction and technology. Specifically, I coded each set of expanded observation notes by characteristics which were sorted into categories (Glaser & Strauss, 1967; Rowe, 1998; Strauss & Corbin, 1990). I then formulated these categories into provisional hypotheses that were reviewed by Ms. Jones and project debriefers. (Lincoln and Guba [1985] recommend that, to acquire impartial feedback, researchers debrief with knowledgeable consultants who are not directly involved in the study.)

Another goal of data analysis was to refine my hypotheses and establish redundancy in my observations (Lincoln & Guba, 1985). I did this by triangulating the hypotheses with a variety of data-collection and analysis techniques. In particular, I conducted weekly formal interviews with Ms. Jones which were tape recorded and transcribed. In addition, daily informal interviews with the students and Ms. Jones, as well as more than 40 hours of classroom activities, were videotaped. The audio- and videotapes were cataloged so they could be readily accessed for comparison with observation notes, student work samples (e.g.,

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animations, multimedia slide shows, written reports), and students' sources (e.g., Web pages, textbook and trade book passages, CD-ROM encyclopedia articles). The audio component of all the videotapes was dubbed onto cassette tapes in order to facilitate the transcription of significant events.

I met frequently with the project debriefers to discuss refinement of the hypotheses and methodological decisions. The debriefers proposed informal interview questions that would help refine hypotheses. The debriefers and the teacher read a final report about the project and offered further suggestions for revision (e.g., providing information on participants' backgrounds). These revisions were incorporated in all reports of the project. Last, by continually generating, refining, and in some cases refuting hypotheses, I developed a systematic way to analyze the data. Through this dynamic process, I was able to examine and empirically ground the instructional approaches that Ms. Jones used to integrate literacy instruction and technology.

Because the findings discussed in this article are based on ethnographic research methodologies, readers should consider the characteristics of this classroom when relating the findings to other settings. This classroom was distinctive in that these students had many opportunities to use technology. Furthermore, 20 of the 26 students had been in a technology-rich third-grade classroom before entering Ms. Jones' class. Most of these 20 students could type at speeds over 30 words per minute. Also, before this study started, these 20 students had spent all of third grade and half of fourth collaborating and using multimedia technologies. Meanwhile, this was Ms. Jones' first year with a fourth-grade class, and her first year teaching in this technology-rich classroom.

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Findings

The inquiry approach. Data collection and analysis revealed that Ms. Jones consistently used an inquiry approach that integrated technology with literacy. The students completed 11 inquiry projects between January and June; two of these were in progress when data collection started, and the remaining nine became the subject of nine case studies. Excerpts from two case studies will be used to highlight the findings reported here.

Data analysis revealed that, in this classroom, over 70 percent of the reading and writing activities that at some point included technology occurred while the students researched or reported their findings within inquiry units. Consider "The Ocean Unit," an inquiry involving a team of four students who investigated ocean tides, tidal waves, and the topography of the ocean floor (see Table 1). The inquiry occurred over 3 days and included six team meetings.

Table 1
Process of the Inquiry Unit

Inquiry Initiation	Conducting the Inquiry	Culmination of Inquiry
Based on the district's curriculum, Ms. Jones announced potential inquiry unit topics	Inquiry teams met to discuss their interests, outline their topics, and discuss how to present their findings	Each student submitted a summary of his or her information to Ms. Jones
Students silently read textbooks to find topics they wanted to investigate	Inquiry teams (3 to 4 students each) went to the school library to find information about their selected topics	Ms. Jones reviewed the summaries and either approved them for presentation or recommended further inquiry
The class met and discussed topics they found interesting and formed inquiry teams based on similar interests	Inquiry teams met to discuss what they found in the library	Students presented their findings by giving each of their classmates a blank outline about the topic (for note taking) and delivering an oral presentation with supporting materials
	Inquiry teams met with Ms. Jones to share what they found in the library and discuss additional classroom resources	Students took notes during presentations and asked questions
	Students examined the materials they gathered to learn more about their topics	Students took a stimulated recall test of the presentations
	Students met to discuss their information and begin preparing presentations	

On the first day of the inquiry, the students silently read their science textbooks and chose the topics they wanted to investigate. The next day, they went to the school library and found additional information from trade books, videotapes, magazines, CD-ROM encyclopedias, and learning kits with narrated filmstrips. They returned to the classroom and found more information from the Web, laser discs, and multimedia encyclopedias. When the ocean inquiry team got together to share findings and decide who would focus on which topics for further research, I recorded their discussion. Following is an excerpt from the transcript (ellipses indicate instances when the students were interrupted and did not complete their statements):

Randy: OK, we have got to have some parts [topics].

Richard: OK, me and Randy are going to do waves.

Randy: We are going to do waves and tides....

Wally: I am going to do earthquakes [under the ocean].

Randy: I know. You [Wally] are earthquakes. Simon, what would you do then since your dad was a sea diver or whatever?

Simon: I am going to talk about what the bottom looks like.

Randy: What the ocean bottom looks like. OK.... OK, let's put [write] this stuff down.

Wally: OK.

The team members then listed one another's names and their selected subtopics on clipboard pads. As a

consequence of their discussion, they decided that Randy and Richard would investigate waves and tides, Wally would research undersea earthquakes that cause tidal waves, and Simon would study the topography of the ocean floor. Next, the team members decided how they would present their information to the class.

Randy: OK, what do you think would be the best [way to present] for our topic?

Simon: OK, what would be good for my thing [the ocean floor] is, like, I could do, we could do a bulletin board.

Wally: I want to [do an] animation of two [continental] plates hitting...and they are all shaking and everything.

Randy: OK, we could do two [presentation formats]. OK?

Richard: Tides would make a good animation....

Randy: Well, that would be a pretty good animation.... [Simon] could you do [an animation of] a deep sea diver [who explores the ocean floor]?

Simon: I could do a poster.

Wally: On a bulletin board.

Richard: Yeah....

Randy: Naw, let's just do animation.

The students offered suggestions for how they might express their research findings. For instance, Wally suggested that he could animate how continental plates shift to illustrate what causes an earthquake, which in turn creates a tidal wave. Richard decided that he, too, could make an animation, in his case of high and low tides. Randy concurred that an animation would effectively communicate how tides are affected by the sun and moon. However, Wally remained unconvinced that an animation would help him teach the class about the topography of the ocean floor (even if he added a deep sea diver).

As this example illustrates, the students talked about their ideas around particular research topics and decided which media (e.g., animation, bulletin board) would best illustrate the meanings they hoped to convey. In the end, Wally did an animation and an illustration of earthquakes under the ocean floor, Richard did an animation of the lunar phases and ocean tides, Randy did an animation of a tidal wave and an illustration of the parts of a wave, and Simon did an illustration of the topography of the ocean floor.

On the morning of the third day of the inquiry project, Ms. Jones told the students that their next task was to find information that was critical to their topics and valuable for sharing with their classmates. Ms. Jones conducted a minilesson about the uses of indexes and outlining information while reading. She then told the students to read the books and magazines they had brought from home or checked out from the school library. She also told them to takes notes while they read, with the goal of developing an outline for their presentations.

After working on this unit for three days and meeting with team members at five designated times, the students met a final time to discuss their presentations, which were to be made a few minutes later. In this excerpt from the ocean inquiry team transcript, Randy spontaneously initiates a discussion about the strategies they could use to prepare for oral presentations:

Randy: Hey Richard, do you write down your info [so you can memorize it for the oral presentation]?

Richard: Well, I did but....

Randy: Do you write it down on the computer normally?

Richard: Well, all I do is just type it on the computer, that is all I do.

Randy: You do? I don't, OK.

Richard: Why?

Randy: Because, see, if you type it on the computer, that's like your memory banks, the computer. If you keep on reading it, your memory banks is in your head so that tells you all your information.... Try to get all the information you can. Just read books. See, reading books helps a lot more than writing down your information and studying it, because if you read books you understand your topic a lot more than you do if you are just writing, copying your information out of a book like most people do and keep on studying it.

Randy apparently discovered another way to prepare for oral presentations: just read books. While Randy only mentions books, he actually got information from Web pages, articles in multimedia encyclopedia, laser dics, videotapes, magazines, filmstrips, and conversations with classmates, the teacher, and his parents. Randy explained to the other members of his team what it meant for him to make sense of the topic they were researching. In effect he communicated to his team that it was not enough to memorize the information or to write it down. Instead, to understand the material, it was more important for him to read various sources and discuss his findings with others.

Throughout this and all other inquiry projects in this class, students read, wrote, and used technology. In this particular unit, the ocean inquiry team needed to use the following literacy-related skills (among others): selecting a topic, selecting appropriate resources, selecting appropriate modes of presentation for the topics and the audience, using indexes, outlining information, taking notes, and identifying strategies to comprehend the information well enough to present it. These students used the following technologies: CD-ROM encyclopedias, the World Wide Web (search engines and Web sites), laser discs, animation software, word processors, graphic importation software, scanners and appropriate software, and drawing software. Throughout, literacy and technology skills were integrated as the students used them in combination in their inquiry process.

The process approach to writing. The other approach that Ms. Jones used consistently to integrate literacy instruction and technology was process writing, which was incorporated within the inquiry projects. At the beginning of the year, she discussed with students how the writing process involved brainstorming, drafting, editing, revising, and publishing. She posted this process on a classroom wall (in the form of a staircase) and consistently announced on which step the students should be working at particular times.

For example, during an inquiry unit about poetry, the whole class analyzed poetry and then students went to their seats to brainstorm their own poetry-related topics for further exploration. Ms. Jones circulated, discussing topics with each student. If students' topics were sufficient and appropriate, Ms. Jones told them they could begin drafting using the computer and word-processing software. Before the students published their compositions, they were expected to request feedback from two or three classmates. Ms. Jones discussed with the class that feedback should begin with at least three positive comments before any suggestions were made. As a culmination of the writing process, students printed out their compositions -- they published their work. These publications were then used during inquiry presentations, posted on bulletin boards, handed out for classmates to take home (in the case of student-created newspapers, for example), or added to the class library for classmates to check out (e.g., reports about regions of the United States).

Jessica's "Robot Story" illustrates how literacy and technology were integrated within the process writing approach. The class had just completed an inquiry unit about aerospace technology, and Jessica had worked

with a team that investigated helicopters. As with the ocean inquiry group, Jessica and her team had silently read textbooks to identify information they wanted to know more about and had searched for information in a variety of classroom and library resources. Jessica's team had then created a Hyperstudio animation to use while presenting to the class.

After all the teams had reported their findings, Ms. Jones gave the students articles to read about robots used in aerospace experiments and rocket construction. She invited the students to write about robots so they could create a class anthology. Jessica, like her classmates, used her word processor and imported graphics to create a story about a robot -- in her case, one named Ashley, who does the household chores for Chelsey, the girl who found her. Before Jessica printed her story to add to the class robot anthology, she invited two classmates, Chuck and Lisa, to read her story from her computer screen. In the following excerpt from the transcript, Chuck and Lisa take turns reading aloud and suggesting changes (italics represent text from Jessica's story itself):

Chuck: *Then Chelsey started school. Ashley started home and cleaned house. A week wented by.*

Jessica: Went by.

Chuck: Went by. You should just cut off that -ed. It should just be, *a week went by.*

Jessica edits her text.

Lisa: *Chelsey said, "What do you want to do, Ashley"* You need to, um... [points to the screen].

Chuck: *"What do you want to do"* Oh, put a question mark right there [points to the screen].

Jessica edits her text.

Lisa: *When they woke up*

Chuck: *When they woke up* **though**?

Lisa: *They watched TV*

Jessica: *When they woke up* ***they*** [correcting Chuck, who had changed "they" to "though"]....

Lisa: There is a *t* there [referring to an omitted *t* in *watched*].

Chuck: Oh yeah, I forgot....

Lisa: *...played games and went outside, and they played with their friends*

Chuck: ...that needs to be capitalized....

Jessica: *Then after that, they went to the zoos and farms. At one farm they rode the bull. The bull killed Ashley. We was so mad* [although Jessica said "mad," it was spelled *made*] *at the bull but I....*

Lisa: Made at the bull?

Jessica changes *made* into *mad.*

Chuck: It keeps saying "after" [meaning that many of the sentences begin with "After"].

Lisa: Why don't you make friends with another robot in the story?

Jessica: Well....

Lisa: Make it a happy ending.

Jessica: Well, I don't want it that happy....

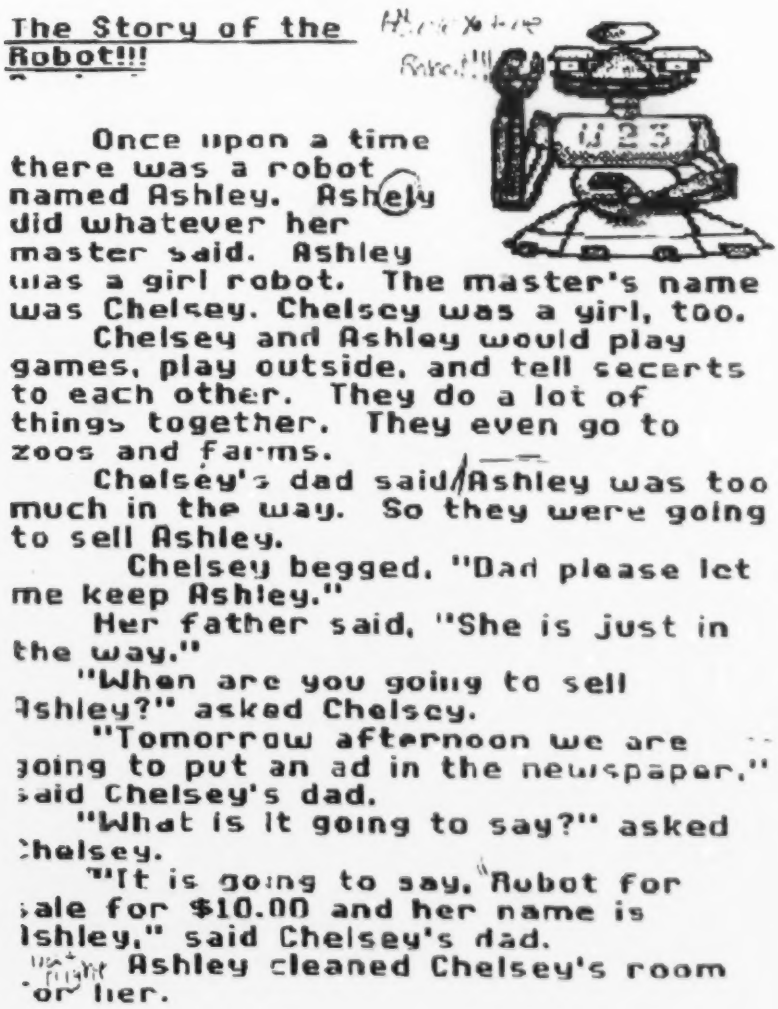
Chuck: That was a very good story....

Jessica: OK, so can I read yours next?

Chuck: Yep.

Jessica continued to revise her story, and within 30 minutes she printed it and gave it to Ms. Jones for further feedback. A page from Jessica's story is shown below.

Figure 2
Sample Page from "Robot Story"



The Story of the Robot!!!

Once upon a time there was a robot named Ashley. Ashley did whatever her master said. Ashley was a girl robot. The master's name was Chelsey. Chelsey was a girl, too.

Chelsey and Ashley would play games, play outside, and tell secerts to each other. They do a lot of things together. They even go to zoos and farms.

Chelsey's dad said Ashley was too much in the way. So they were going to sell Ashley.

Chelsey begged, "Dad please let me keep Ashley."

Her father said, "She is just in the way."

"When are you going to sell Ashley?" asked Chelsey.

"Tomorrow afternoon we are going to put an ad in the newspaper," said Chelsey's dad.

"What is it going to say?" asked Chelsey.

"It is going to say, Robot for sale for $10.00 and her name is Ashley," said Chelsey's dad.

Ashley cleaned Chelsey's room for her.

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Several literacy skills were addressed during this interaction. In particular, Jessica, Chuck, and Lisa discussed the following:

- spelling (there is a *t* in *watched;* take the *e* from *made* to spell *mad*)
- syntax (remove *-ed* from *wented*)
- characterization ("Why don't you make friends with another robot?")
- plot development ("Make it a happy ending")
- punctuation ("Put a question mark there")

In creating her story, Jessica used a computer with word-processing and graphics capabilities; she also used the computer to print her final draft. In this way, the process writing approach in this classroom integrated literacy skills and technology.

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The Challenges of Integration

While Ms. Jones found that the inquiry approach and process writing facilitated the integration of literacy instruction and technology, she also encountered some challenges. During my five months in her classroom, I observed that Ms. Jones had to address the following:

- Students' ability to analyze the quality of sources
- Students' ability to create substantive products that went beyond simply being "flashy"
- Students' ability to deal with conflicting or inaccurate information
- The accuracy of what students reported
- Students' privacy

While this is not an exhaustive list, these challenges represent those that Ms. Jones experienced consistently as well as those that relate to integrating literacy instruction and technology.

Analyzing the quality of sources. Ms. Jones had to provide ample instruction on what she called "finding the meat" in various sources. Some sources the children found were "flashy" but had little content to convey. For example, students might spend time viewing online animations of U.S. Civil War battles, but these animations might not explain those battles or give background information about the war. Ms. Jones modeled how to find and outline the "meat" in encyclopedias, textbooks, Web pages, and other sources. The students then became mindful of the need to examine whether relevant information could be obtained from the sources they located.

For example, in an interview with Jessica, I asked why she had read particular sources. She stated that she read in order "to get meat." I asked another student, Troy, if he had read about his inquiry topic. He replied, "Yes. We call information meat." Troy, like Jessica and others, read to find information -- meat. When Ms. Jones met with the inquiry teams to discuss their findings, she repeatedly asked what information they had found and what they planned to teach the class.

Creating substantive products. Ms. Jones and her students had to develop criteria for examining the quality of products they made in the classroom. Some students thought that creation of a flashy animation or multimedia presentation indicated adequate research and presentation of a topic. For example, in an inquiry project on the evolution of the American flag, Jessica simply scanned a page of different American flags. Her work was complete, she felt -- she would simply show her class a slide show of the different flags. When Ms. Jones asked about the flags, Jessica was unable to explain why they had different numbers and configurations of stars, or what the stripes represented. Ms. Jones provided instruction about the need not only to "find meat" in information sources but also to create products that communicated that meat.

Coping with conflicting or inaccurate information. Students sometimes found conflicting or inaccurate information in the large number of sources available to them. For example, while one student was researching the Himalayas, he found three different heights for the tallest mountain. Ms. Jones then discussed with this

student the need to examine the age of the information source and to confirm information in two or three sources.

Verifying the accuracy of student reports. Because the students had access to many sources, Ms. Jones faced a dilemma: she could not verify the accuracy of information for every topic. In classrooms where students use only the school district's mandated textbooks, the teacher knows where the students obtain their information and is able to confirm the accuracy of its reporting. To deal with this dilemma, Ms. Jones required students to cite references and be ready to locate the information if it was called into question. In other words, in the fourth grade, these students learned how to reference information.

Providing privacy. Because the students' writings were on computer screens, anyone could walk by and read them. When I asked Simon what it was like to have his writing available for anyone to read, he stated, "If journals are on screen, we usually turn off our monitors" -- that is, if he had a journal file open, Simon would turn off his monitor to darken the screen if he left his seat. In other words, Simon felt that an audience was so inevitable that he had to turn off his monitor when he was not composing.

The "publicness" of the students' writings did foster collaboration, which resulted in valuable interactions (e.g., Jessica's robot story). However, Ms. Jones knew that it might also create anxiety for students who did not want their brainstorming or drafts to be open to public scrutiny. She tried to minimize the potential negative effects of this scrutiny by instructing students always to tell an author three things they liked about a composition before mentioning one or two questions or suggestions.

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Discussion

Many studies have investigated aspects of the integration of literacy instruction and technology, but few have examined the instructional approaches used for such integration. This study identified two instructional approaches through which Ms. Jones was able to integrate literacy and technology: inquiry and process writing. The findings presented here may be useful to other teachers who are seeking ways to accomplish a daunting task: teaching children to be proficient readers, writers, and technology users.

Readers do need to be mindful of the limitations of this study. Because this was an ethnography, I examined what occurred naturally in an actual classroom -- in this case, one where inquiry and process writing were in use. I am therefore unable to state whether other approaches -- basals, the language experience approach, or literature-based literacy programs -- can help teachers integrate literacy and technology. Further studies are needed to investigate whether other approaches promote integration. Further investigations are also needed to clarify whether similar findings might emerge in classrooms with limited or different technology resources, or with student populations that included children with special needs.

Inquiry and process writing have a longer history in our schools than does technology, yet I found that these two approaches were readily adapted to embrace technology. This study corroborates other investigations that have found that technology can empower the learner (Beach & Lundell, 1998; Fisher, 1988, online abstract; Labbo & Kuhn, 1998), foster collaboration (*Apple*, 1991, online abstract; Beach & Lundell; Daiute, 1985; Labbo & Kuhn; Newman, 1990; Sheingold, 1991), effectively integrate content areas (Zorfass & Copel, 1995), and develop students' awareness of audience (Baker, Rozendal, Whitenack, in press) -- all of which are also attributes of the inquiry approach or the process approach to writing.

On the other hand, this investigation revealed that integration of literacy and technology through these approaches is not without challenges. I propose, however, that these challenges can provide valuable learning opportunities. For example, the students in this class learned that although an animation or multimedia slide show may look "slick," without substance it has minimal value. In our increasingly technological culture, such learning may prove important as these students develop into savvy consumers who can recognize the difference between glitz and quality. Similarly, these students may be better prepared to create quality products for their future employers. If such qualities and abilities can be fostered across the grades, it seems plausible that students could become well equipped to secure well-paying jobs.

Because the various technologies available in Ms. Jones' class and the school library gave her students access to many sources of information, they had to learn to evaluate the accuracy of that information. They also learned how to reference their information. Both verifying information and referencing information are important literacy skills, though they have not traditionally been part of the curriculum until well after fourth grade. The technology available in this classroom introduced the need for these skills and provided contextualized opportunities to use them.

The need for privacy is a challenge that merits further consideration. Teachers could provide overlays which make it difficult to read online text unless the reader is situated directly in front of the screen; alternately, computers could be set up in carrel units. Ms. Jones established a supportive classroom atmosphere by insisting that students compliment others' work before making suggestions. Nevertheless, if students compos on computer monitors that are open to public view, teachers need to be mindful of issues of privacy.

This study contributes to the growing body of research and professional literature about the integration of literacy instruction and technology. Specifically, it offers insights into the integration of technology and specific instructional approaches that may be applicable to other settings and levels of resources. Further studies will help clarify the usefulness of these and other approaches to integrating literacy instruction and technology.

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